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SCREENING SINGLE RESISTANCE OF *Eleusine indica* ON OIL PALM PLANTATION IN PADANG LAWAS AND TAPANULI SELATAN REGENCY INDONESIA

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Abstract: *Eleusine indica* population from several estates in Padang Lawas and Tapanuli Selatan Regency, Sumatera Utara Indonesia has never been reported to be resistant to glyphosate herbicide. This study aims at distribution mapping and resistance classification of *Eleusine indica* glyphosate-resistant populations from several estates in Padang Lawas and Tapanuli Selatan Regency, Sumatera Utara. This research was conducted at Weed Research Center of the Faculty of Agriculture, Universitas Sumatera Utara from October 2016 to August 2017. This research used glyphosate at the recommended rate of 720 g ai ha^{-1} and three replications. Population ESU_0 (from Politeknik Negeri Medan Ball Field) as a comparison. Data analysis using t-test at the level of 5% with IBM SPSS Statistics 20 software. The results showed 22 populations in Padang Lawas Regency have 8 populations classified as glyphosate-resistant (36.36%), 8 populations classified as developed-resistant (36.36%), and 6 populations classified as glyphosate-susceptible (27.27%). While from 6 populations in Tapanuli Selatan Regency have 5 populations classified as glyphosate-resistant (83.33%), 1 populations classified as developed-resistant (16.67%), and 0 populations classified as glyphosate-susceptible (0%).

Keywords: glyphosate, goosegrass, oil palm plantation, resistance.

I INTRODUCTION

Goosegrass [*Eleuisine indica* (L.) Gaertn] is one type of weed that is commonly found and cause problems in oil palm plantations. Similar herbicide use for a long time tends to lead to a succession of weeds. If at the beginning of the use of the herbicide found the types of weeds that diverse but after the use of the herbicide repeatedly diversity and weeds to be low once the dominant weed species becomes more difficult to control [1].Goosegrass is classified as a weed that grows rapidly so that full control is required. These weeds flower throughout the year and each plant can produce up to 140,000 seeds per plant [2] and has been reported glyphosate-resistant from several oil palm plantations in Sumatera Utara [3,4,5,6,7]. Since plantations recognize the use of glyphosate-herbicides, used glyphosate-herbicides dominate chemical weed control in plantations. Indonesia, especially the Sumatera Utara province is dominated by oil palm plantations. Area oil palm plantations Sumatera Utara Province in 2017 amount 1.47 million ha. Padang Lawas and Tapanuli Selatan Regency, Sumatera Utara Province have oil palm plantations area 33,715 (2.29%) and 5,288 (0.36%) hectare respectively [8]. Plantations cannot be separated from the use of herbicides in weed control. Goosegrass population from several estates in Padang Lawas and Tapanuli Selatan Regency, Sumatera Utara Indonesia has never been reported to be resistant to glyphosate herbicide. It is necessary to distribution mapping of glyphosate-resistant goosegrass populations in plantations. The purpose of this study is to map and classify distribution resistance of goosegrass population to glyphosate herbicide from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency, Sumatera Utara.

II MATERIALS AND METHODS

Collecting seeds of glyphosate-resistant and susceptible *E. indica* population

Collecting seeds of glyphosate-resistant *E. indica* population were taken the mature seeds are marked in panicles already tanned as many as 50 plants from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency (Table 1). Collecting seeds of *E. indica* glyphosate susceptible population (ESU_0) were

Table 1 Collecting goosegrass population seeds from oil palm estates in Padang Lawas and Tapanuli Selatan Regency

Location/Estate	Code sample
Padang Lawas Regency	
1 Afdeling, Sei Kebara Estate	$ESU_{2.140}$
2 Afdeling, Sei Kebara Estate	$ESU_{2.141}$
3 Afdeling, Sei Kebara Estate	$ESU_{2.142}$
4 Afdeling, Sosa Estate	$ESU_{3.107}$
5 Afdeling, Sosa Estate	$ESU_{3.108}$
6 Afdeling, Sosa Estate	$ESU_{3.109}$
7 Afdeling, Sosa Estate	$ESU_{3.110}$
8 Afdeling, Sosa Estate	$ESU_{3.111}$
Oil palm nursery, Sosa Estate	$ESU_{3.112}$
1 Afdeling, Paya Baung Estate	$ESU_{9.11}$
2 Afdeling, Paya Baung Estate	$ESU_{9.12}$
3 Afdeling, Paya Baung Estate	$ESU_{9.13}$
1 Afdeling, Bukit Udang Estate	$ESU_{10.1}$
2 Afdeling, Bukit Udang Estate	$ESU_{10.2}$
3 Afdeling, Bukit Udang Estate	$ESU_{10.3}$
4 Afdeling, Bukit Udang Estate	$ESU_{10.4}$
5 Afdeling, Bukit Udang Estate	$ESU_{10.5}$
Oil palm nursery, Bukit Udang Estate	$ESU_{10.6}$
1 Afdeling, Nagar-gar Estate	$ESU_{10.7}$
1 Afdeling, Papaso Estate	$ESU_{10.8}$
2 Afdeling, Papaso Estate	$ESU_{10.9}$
3 Afdeling, Papaso Estate	$ESU_{10.10}$
Tapanuli Selatan Regency	
1 Afdeling, Batang Toru Estate	$ESU_{2.143}$
2 Afdeling, Batang Toru Estate	$ESU_{2.144}$
3 Afdeling, Batang Toru Estate	$ESU_{2.145}$
4 Afdeling, Hapesong Estate	$ESU_{2.146}$
Oil palm nursery, Hapesong Estate	$ESU_{2.147}$
1 Afdeling, Langga Payung Estate	$ESU_{9.14}$
Total	**28 samples**

taken from Politeknik Negeri Medan Ball Field, where the herbicide was never applied. Collecting seeds was conducted in September until December 2017.

Germination and Transplanting

Seeds of *E. indica* are soaked in potassium nitrate solution (KNO_3) with 0,2% concentration for 30 min [9]. Soaking aims to break *E. indica* seed dormancy. The seedling medium used is topsoil and manure with a volume ratio of 1:1. After thoroughly mixed, the medium was put on a temperature 100^{o}C for 3 h and then inserted into the germination trays measures 33 cm × 24 cm. After 2-3 leaf stage, seedlings from each species were transplanted into pots with topsoil, sand and manure medium was filtrated with volume 1:1:1 ratio. Transplanted 10 plants into pots. The pots were arranged in a randomized block design (RBD) non-factorial with three replications.

Glyphosate Application

Before spraying first performed calibration (292 l/ha). Glyphosate spraying is were made at 3-4 leaf stage [10]. The sprayed with glyphosate herbicide at the recommended rate of 720 g ai ha^{-1} (Round-up 486 SL, PT. Menagro Kimia).

Statistical

Parameters observed among *E. indica* survival, dry weight and resistance classification. Observation of *E. indica* survival was made at 21 days after application (21 DAA) for pot respectively [11]. The percentage of *E. indica* survival (% ES) was calculated using the formula of sum *E. indica* survival (SES) per sum *E. indica* was planted (SEP) x 100% (Eqs. (1)). Observation dry weight of goosegrass was made at 6 weeks after application (6 WAA). Above-ground shoots were harvested and dried in the oven (65°C) for 72 h [11] for dry weight measurements.

$$\% \text{ ES } = \frac{\text{SES}}{\text{SEP}} \text{ x } 100\% \quad (1)$$

Resistance classification measured by the percentage of survival population. Populations were classed as resistant (20% or more survival), as developing resistance (2–19% survival), or as susceptible (less than 2% survival) [12]. Data analysis using t-test at the

Table 2 Effect of glyphosate application at 720 g ai ha^{-1} to percentage plant survival, dry weight and resistance classification of *Eleusine indica* in Padang Lawas and Tapanuli Selatan Regency.

No	Sample Code	Plant Survival (%)			Dry Weight (g)			Resistance Classification		
		$\overline{X}$	t-test		$\overline{X}$	t-test		S	DR	R
1	ESU_0	0.00	-	-	0.00	-	-	√	-	-
Padang Lawas Regency										
2	$ESU_{2.140}$	60.00	3.93	ns	15.69	2.82	ns	-	-	√
3	$ESU_{2.141}$	80.00	8.00	*	15.18	85.35	*	-	-	√
4	$ESU_{2.142}$	83.33	9.45	*	22.61	19.52	*	-	-	√
5	$ESU_{3.107}$	43.33	3.25	ns	7.86	3.47	ns	-	-	√
6	$ESU_{3.108}$	56.67	3.90	ns	12.85	6.84	*	-	-	√
7	$ESU_{3.109}$	30.00	1.44	ns	5.64	1.55	ns	-	-	√
8	$ESU_{3.110}$	33.33	5.00	*	6.88	5.35	*	-	-	√
9	$ESU_{3.111}$	0.00	0.00	*	0.00	0.00	*	√	-	-
10	$ESU_{3.112}$	10.00	1.73	ns	3.07	1.69	ns	-	√	-
11	$ESU_{9.11}$	0.00	0.00	*	0.00	0.00	*	√	-	-
12	$ESU_{9.12}$	0.00	0.00	*	0.00	0.00	*	√	-	-
13	$ESU_{9.13}$	0.00	0.00	*	0.00	0.00	*	√	-	-
14	$ESU_{10.1}$	16.67	1.00	ns	2.86	1.00	ns	-	√	-
15	$ESU_{10.2}$	10.00	1.00	ns	3.34	1.00	ns	-	√	-
16	$ESU_{10.3}$	3.33	1.00	ns	0.96	1.00	ns	-	√	-
17	$ESU_{10.4}$	6.67	1.00	ns	1.39	1.00	ns	-	√	-
18	$ESU_{10.5}$	0.00	0.00	*	0.00	0.00	*	√	-	-
19	$ESU_{10.6}$	96.67	29.00	*	23.58	6.41	*	-	-	√
20	$ESU_{10.7}$	6.67	1.00	ns	1.11	1.00	ns	-	√	-
21	$ESU_{10.8}$	10.00	1.73	ns	1.61	1.72	ns	-	√	-
22	$ESU_{10.9}$	3.33	1.00	ns	0.70	1.00	ns	-	√	-
23	$ESU_{10.10}$	0.00	0.00	*	0.00	0.00	*	√	-	-
Tapanuli Selatan Regency										
24	$ESU_{2.143}$	43.33	3.61	ns	10.24	5.92	*	-	-	√
25	$ESU_{2.144}$	100.00	0.00	*	26.90	7.26	*	-	-	√
26	$ESU_{2.145}$	3.33	1.00	ns	1.43	1.00	ns	-	√	
27	$ESU_{2.146}$	50.00	1.99	ns	12.03	2.38	ns	-	-	√
28	$ESU_{2.147}$	77.78	4.58	*	16.98	13.71	*	-	-	√
29	$ESU_{9.14}$	46.67	5.29	*	11.41	4.42	*	-	-	√

Note : * = significant differences with sig < 5%, ns = no significant differences with sig > 5%
S = Susceptible (< 2%), DR = Developing Resistant (2 - ≤ 20%), R = Resistant (≥ 20%)

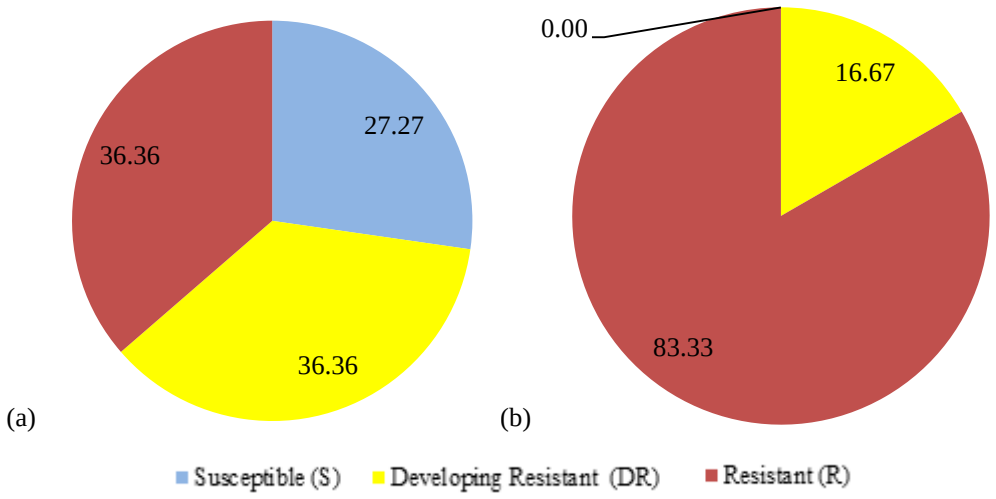

Figure 1 Resistance classification of *Eleusine indica* to glyphosate dose at 720 g ai ha^{-1} from oil palm estates in (a) Padang Lawas and (b)Tapanuli Selatan Regency

level of 5% with IBM SPSS Statistics v. 20 software (New York: United States).

III RESULT AND DISCUSSION

Based on screening test *E. indica* population was found the percentage survival, dry weight and resistance classification with recommendation dose at 720 g ai ha^{-1} (Table 2). It shows the population of several oil palm estates in Padang Lawas and Tapanuli Selatan Regency for each section had different survival compared to susceptible population (ESU_0).The survival *E. indica* population percentage from several oil palm estates in Padang Lawas Regency highest at $ESU_{10.6}$ (Oil palm nursery, Bukit Udang Estate) amount 96.67% and Tapanuli Selatan Regency highest at $ESU_{2.144}$ (2 Afdeling, Batang Toru Estate) amount 100%. This indicates that the population has been intensely exposed to glyphosate herbicides so that it has experienced glyphosate resistance. It is thought *E. indica* has the mechanism of glyphosate-resistant by reducing active ingredient of herbicide translocation to target site which because of changes in target site the weed. This is change target site on weed that glyphosate caused inhibit enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). Inhibited result the shikimic acid accumulation in chloroplast tissue. It is suitable to research [5] which glyphosate-resistant goosegrass population collected from Adolina Estate, Serdang Bedagai Regency, Sumatera Utara was resistant to glyphosate 100% at 480 g ai ha^{-1} and resistance index value to glyphosate amount 7.5-fold of the susceptible population.

Then Ref. [7] confirmation goosegrass from 58 blocks in Adolina Estate, Serdang Bedagai Regency also resistant to glyphosate amount 98.28% (57 population) at 480 g ai ha^{-1}. This is in accordance with the opinion [13] which there are two mechanisms of resistance weeds of glyphosate herbicide, which is to reduce the translocation of glyphosate herbicide and change target site of weed. Moreover [14] which glyphosate-treated chloroplast tissue the levels of shikimate are increased. Shikimate accumulation is due to glyphosate inhibiting the chloroplastic enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). EPSPS is the penultimate enzyme in the aromatic amino acid biosynthetic pathway that occurs in the chloroplast and converts shikimate-3-phosphate (S-3-P) to enolpyruvylshikimate-3-phosphate (EPSP) and eventually leads to the production of the amino acids phenylalanine and tyrosine, as well as tryptophan. Shikimate builds up in glyphosate-treated plants because S-3-P cannot be converted to EPSP, and because S-3-P is unstable, it is rapidly converted to the more stable shikimate, which accumulates.

The dry weight of *E. indica* population from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency highest at $ESU_{10.6}$ (Oil palm nursery, Bukit Udang Estate) amount 23.58 g. The dry weight of *E. indica* population from several oil palm estates in Tapanuli Selatan Regency is highest at $ESU_{2.144}$ (2 Afdeling, Batang Toru Estate) amount 26.90 g. This indicates the population has the ability to photosynthesize without delay from glyphosate herbicides at dose 720 g ai ha^{-1}. It is assumed that the translocation of ^{14}C-glyphosate to *E. indica* shoot tissue is lowest. Lowest translocation of ^{14}C-glyphosate on shoot tissue weed makes the active ingredient glyphosate herbicide is not effective. It can be seen during visual observation in the field, only yellow weeds in a few days and then re-grow and productive tillers. This is according [15] which the translocation ^{14}C-glyphosate of *E. indica* shoot tissue exposed glyphosate herbicide amount 10.9% and 2.8% in roots. Differences in retention of ^{14}C-glyphosate on shoot tissue exposed to herbicides and translocation the whole shoot can because of resistance to glyphosate.

Resistance classification of *E. indica* on glyphosate application at dose 720 g ai ha^{-1} from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency (Fig 1). There is 22 *E. indica* population collecting from several oil palm estates in Padang Lawas Regency to glyphosate application dosage 720 g ai ha^{-1}. If the population is classified, there are 8 were classified as glyphosate-resistant (36.36%), 8 population classified as developing resistance (36.36%), and 6 population were classified as susceptible (27.27%). There is 6 *E. indica* population collecting from several oil palm estates in Tapanuli Selatan Regency to glyphosate application dosage 720 g ai ha^{-1}. If the population is classified, there are 5 were classified as glyphosate-resistant (83.33%), 1 population classified as developing resistance (16.67%), and 0 population were classified as susceptible (0%). The number of the population classified as glyphosate-resistant from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency will have an impact on the quality of oil palm production. This indicates that *E. indica* population from several oil palm estates in Padang Lawas and Tapanuli Selatan Regency has dominated resistant populations to the glyphosate herbicide. This indicates that *E. indica* from several oil palm estates in Padang

Lawas and Tapanuli Selatan Regency for several years exposed to herbicide with the active ingredient and the same dose of glyphosate herbicide so resistant dominant. This is consistent with the literature [1] which that consequences of use the herbicide the same (the same kind of active ingredients or the same way of working) repeatedly for long periods in an area may problems that produce is going on weed population dominance of herbicide-resistant or herbicide tolerant weed-dominance. This indicates that use of glyphosate herbicide has been intensive to control weeds in the oil palm plantation on Padang Lawas and Tapanuli Selatan Regency. The use glyphosate herbicide continuously in oil palm plantations will result in economic and technical field losses. This is related with results of direct interviews with manager in several estate saying that each spraying weeds with glyphosate recommendation dose at 2 l/ha (720 g ai ha^{-1}), especially *E. indica* only weak a few days after application and then grow up and tillers until seed production.

CONCLUSION

There is 22 goosegrass population from several oil palm estates in Padang Lawas Regency have 8 population were classified as glyphosate-resistant (36.36%), 8 population classified as developing resistance (36.36%), 6 population were classified as susceptible (27.27%) and 6 goosegrass population from Tapanuli Selatan Regency have 5 were classified as glyphosate-resistant (83.33%), 1 population classified as developing resistance (16.67%), 0 population were classified as susceptible (0%) at 720 g ai ha^{-1}.

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